Ed Process Int J

www.edupij.com

ISSN 2147-0901 (Print), 2564-8020 (Online)

EDUCATIONAL PROCESS INTERNATIONAL JOURNAL

Research Article

Cite this article: Kahar, M. S., Irmawati, Fathurrahman, M., Suparman, S. Simpol, W., & Ali, M. (2025). Development of the Component Display Theory Model for Enhancing Problem-Solving Skills. *Educational Process: International Journal, 15*, e2025175. https://doi.org/10.22521/edupij.2025.15.175

Received February 13, 2025
Accepted April 2, 2025
Published Online April 24, 2025

Keywords: Learning model, component display theory, problem solving, university students

Development of the Component Display Theory Model for Enhancing Problem-Solving Skills

Muhammad Syahrul Kahar, Irmawati, Muhammad Fathurrahman, Suparman Suparman, Wanida Simpol, Muhammad Ali

Author for correspondence:
Muhammad Syahrul Kahar
syahrulkahar@um-sorong.ac.id
Universitas Muhammadiyah Sorong (Southwest Papua, Indonesia)

Abstract

Background/purpose. The application of learning models is expected to significantly promote the enhancement of students' problem-solving abilities through the development of interactive learning models. This study aims to (1) determine whether the Development of the Component Display Theory (CDT) Model is categorized as valid, practical, and effective and (2) assess whether the Development of the CDT Model can improve Problem-Solving Skills.

Materials/methods. The development of the CDT model was carried out through the 4-D model stages (Define, Design, Develop, Disseminate). Data collection instruments included test instruments, validation, and student response. Subsequently, data analysis techniques used included N-Gain test, response test, and practicality test of the students.

Results. The validation results by construction experts were 3.67 with a percentage of 91.67, categorized as "valid," and the content validation results had an average of 3.63 with a percentage of 90.67, also categorized as "valid." Student response results obtained an average score of 3.97 with a percentage of 79.41, falling within the "practical" category. Furthermore, the improvement in problem-solving skills achieved an N-Gain value of 0.48, categorized as "moderate" and "sufficiently effective," indicating that the developed CDT model meets the practicality criteria and is effective enough to enhance students' problem-solving abilities.

Conclusion. The conclusions of this study are (1) the developed CDT model is categorized as valid, practical, and effective, and (2) there is an improvement in problem-solving abilities of the students using the CDT model.

1. Introduction

Physics learning is often challenged when students attempt to understand abstract concepts and apply them in problem-solving. Many studies indicate that abstract physics concepts can hinder students' comprehension and academic performance (Tenzil et al., 2022). Problem-solving skills are essential in learning to enhance students' problem-solving ability during classroom activities. With strong problem-solving skills, students can easily tackle challenges in every learning process without relying on the teacher's assistance. As a result, even without the teacher providing a detailed explanation of a given problem, students can still understand and analyze each aspect of the problem independently (Faoziyah, 2022).

Several common factors have been identified as causes of students' difficulties in understanding physics concepts and solving problems. Research by Renddy et al. (2017) revealed that (1) A survey of high school students showed that more than 50% of students consider a lack of basic understanding of physics concepts as the main obstacle in problem-solving. Students struggle to recall and apply the correct physics equations without a strong conceptual foundation when faced with problems. (2) Approximately 55.1% of students admitted that the lack of practice in solving physics problems in class hinders their abilities. Limited practice makes students less skilled in analyzing new problems or connecting abstract concepts to practical applications. (3) Nearly half of the students (45.8%) identified weaknesses in the mathematical skills required to understand physics problems as a challenge.

The abovementioned factors lead to a decline in students' motivation and confidence in physics and confusion when they need to connect various abstract topics into a cohesive understanding (Renddy et al., 2017). The accumulation of these challenges highlights the need for innovative learning strategies that can bridge the understanding of abstract concepts and enhance students' problem-solving skills (Lestari, 2020). Indraswati et al. (2020) stated that with problem-solving skills, students can develop a deep understanding of problems, synthesize information, and draw conclusions to solve social issues in a structured, evaluative, and reflective manner, enabling them to meet the challenges of the 21st century.

This aligns with research by Dwi Putra (2018), which indicates that students are not yet accustomed to solving problem-based questions, making it difficult for them to comprehend the information within the problems. Students still need training in handling questions that require higher-order thinking so that their mathematical problem-solving skills can develop effectively. Similarly, Yuniara et al. (2023) reported that field observations show students' problem-solving abilities are still low. Even though students may enjoy the subject, it does not necessarily mean they can effectively solve the given problems, as solving such problems requires precision and skill rather than just interest.

Students are often accustomed to working on routine problems that can be solved directly without requiring a deep understanding. Furthermore, students tend to memorize formulas, leading to confusion about using the correct formulas due to a lack of understanding. Many students make errors in solving problem-solving tasks because they are not used to them, have difficulties understanding the problems, make mistakes in calculations, and fail to check their answers (Damayanti & Kartini, 2022).

One of the innovative learning models proposed to address the challenges mentioned above is the Component Display Theory (CDT) introduced by M. David Merrill. CDT is an instructional design framework that classifies learning materials into two main dimensions: content (facts, concepts, procedures, principles) and performance (remembering, using, discovering) (Merrill, 1983).

https://doi.org/10.22521/edupij.2025.15.175 Published online by Universitepark Press

Gdi & Hidayanto (2016) stated that before adopting the Component Display Theory (CDT) model, student learning outcomes were relatively ineffective. Classroom learning was often monotonous and boring, which deterred students from engaging in the learning process. It was observed that the scores of the student group taught using a CDT-based learning design were significantly higher compared to those taught through conventional methods. The CDT model encourages students to play an active role in their learning, challenging them to utilize all their potential. Students are able to construct their own understanding with the teacher acting as a facilitator. This involves activities such as data analysis, comparison, and providing relevant examples that students can undertake. By adopting the CDT learning model, students are able to enhance their learning outcomes, which positively affects the typically boring and monotonous classroom atmosphere. (Sayang et al., 2021) Furthermore, students are trained to remember, apply, and discover information from learning materials that include facts, concepts, principles, and procedures.

Mataram & Hidayati, (2019) argue that problem-solving skills facilitate students' ability to understand, connect, and use mathematical concepts. The level of creativity among students also plays a significant role in their problem-solving abilities during the teaching and learning process. Their research findings indicate that higher creativity leads to enhanced problem-solving capabilities among students (Sambada, 2012).

In line with the research by Wantu, Djafri, Lamatenggo, and Umar (2022), which states that an additional layer called "believing" has been incorporated into the Component Display Theory (CDT), this study aims to further expand the CDT model by adding a "creation" level. The inclusion of the creation level is expected to enable students to engage creatively during the learning process, as described in cybernetic theory, which posits that individuals learn and adapt to their environment. With this new component, students are also anticipated to use feedback received during learning activities to identify mistakes or shortcomings in their actions, both in learning and in completing assigned tasks. Previously, CDT included three levels of operation: remembering, using, and finding. By integrating the creation level, it is believed that students' understanding and problem-solving capabilities will be significantly enhanced.

Therefore, an instructional approach is required that not only centers on the teacher but also actively engages university students in developing a deep understanding of concepts and applying them in real-world contexts. One promising approach that supports this goal is the Component Display Theory (CDT), introduced by M. David Merrill. CDT is an instructional design theory that categorizes learning content into two main dimensions: content types (facts, concepts, procedures, and principles) and learning performances (remembering, using, and discovering). This structure enables instruction to be systematically and progressively organized, allowing learners to actively construct knowledge from basic to more complex levels.

In higher education, problem-solving ability is recognized as a crucial higher-order thinking skill that students must possess, particularly in analytical subjects such as mathematics and physics. This skill encompasses not only the ability to solve problems but also the capacity to analyze situations, formulate solution strategies, evaluate alternative approaches, and reflect on the results obtained.

This study holds considerable significance as it integrates the CDT approach with problem-solving-based learning to develop an interactive instructional model that is valid, practical, and effective for university students. By systematically developing the model through the 4D framework (Define, Design, Develop, Disseminate), it is expected to serve as an alternative instructional strategy that enhances students' problem-solving skills comprehensively and contributes to the advancement of innovative teaching practices in higher education.

https://doi.org/10.22521/edupij.2025.15.175 Published online by Universitepark Press

2. Literature Review

2.1. Learning Model

Despite the application of various educational models, a considerable number of students continue to struggle with grasping physics concepts and utilizing them practically (Purnawati et al., 2023). Current teaching models often limit active student engagement, thereby impeding the advancement of essential critical and creative thinking abilities (Ceberio et al., 2016). Component Display Theory (CDT) is recognized as a promising educational model that could address these issues, providing a well-organized framework that enhances students' comprehension and problem-solving skills (Troussas et al., 2021; Khan & Mustafa, 2019b; Park et al., 2022).

2.2. Component Display Theory

The Component Display Theory (CDT) incorporates teaching elements such as recall, application, and discovery of information, enhancing learners' comprehension and practical application across various scenarios. This makes CDT a viable strategy for bolstering problem-solving abilities in physics education (Merrill, 2007; Merrill, 2018). The efficacy of learning models is closely tied to an educator’s understanding of students’ developmental processes within the classroom. Active learning techniques have proven to improve educational outcomes by promoting student interaction (Li et al., 2022). CDT particularly supports active involvement and effective problem-solving by providing a structured approach that encourages students to memorize, utilize, and explore information systematically. Although numerous studies have affirmed the benefits of CDT in enhancing educational results, its effectiveness in significantly boosting students' creative skills needs more investigation (Kahar et al., 2023; Merrill, 1987). Moreover, the role of educators in nurturing creativity to improve the educational experience is an area needing more focus (Kahar et al., 2023). Critiques of CDT suggest that while it fosters a more interactive learning environment, it does not adequately support students in independently building knowledge, thus questioning its effectiveness in providing a thorough understanding (Renkl & Scheiter, 2017).

The Component Display Theory (CDT) holds promise for enhancing educational outcomes and deepening students' comprehension (Wantu et al., 2023; Purnawati et al., 2023). Nonetheless, its deployment in physics education requires more robust support and deeper insights to fully leverage its effectiveness in boosting students' problem-solving capabilities. Research by Li et al. (2022) and Cahyanto and Afifulloh (2020) reveals that CDT's current application in educational settings does not adequately allow students to independently and creatively develop their problem-solving skills. Furthermore, Renkl and Scheiter (2017) found that CDT’s impact in physics education does not fully extend to enabling students to apply learned concepts in real-world contexts. (Kahar et al., 2023) suggest that while CDT fosters understanding, additional research is necessary to optimize its use in physics education for better results. Additionally, the physics instructional materials being used are designed to align with the educational levels of students, as outlined by Wells et al. (1995).

3. Methodology

This study employs a research and development methodology with a one-group pretest-posttest design. The product generated is an advanced set of procedures within the Component Display Theory (CDT) model. This research will utilize the 4D model, a straightforward instructional design model that aids researchers in designing products that enhance learners' abilities during the learning process (Gorbi Irawan et al., 2018). The focus of this study is the development of the CDT model and problem-solving capabilities. The 4D model stands for Define, Design, Development, and Dissemination, developed by Thiagarajan (1976). The educational tools designed are intended to meet criteria of validity, practicality, and effectiveness, and are expected to improve students' problem-solving skills.

3.1. Research and Development Procedure

The 4-D (four D) development model is a framework that consists of four stages of development processes: the Define stage, the Design stage, the Develop stage, and the Disseminate stage (Thiagarajan, 1976). This model systematically guides the creation and implementation of educational tools or programs by ensuring that each phase contributes to building an effective and practical learning environment.

1) Define

This initial stage involves defining the development requirements through needs analysis, curriculum analysis, and material analysis. Researchers gather and analyze information to determine the extent of development required (Hariyanto et al., 2022). The outcomes of this stage are crucial for deciding what elements need to be included in the product and how it should be developed.

2) Design

During the design phase, the details of how the product will be developed are determined, including the selection of teaching media and tasks. This stage also involves sketching out the steps of the product development process and establishing a clear blueprint for moving forward.

3) Development

This stage is where the actual creation of the product takes place, adhering to the specifications set out in the design phase and incorporating feedback from experts and initial trials with learners. Subsequent trials are conducted with students in real-class settings. This phase aims to review and refine the learning model developed by the researcher, enhancing it into a more effective educational tool.

4) Disseminate

The final stage involves the dissemination of the finished product. This stage marks the rollout of the developed educational tool or program, making it available for broader use and implementation.

3.2. Product Trial

Product Testing Procedure The product testing in this study is intended to collect data that can be used as a basis to determine the effectiveness, feasibility, and practicality of the developed product (Kristianti & Julian, 2017). In this research, the product testing was conducted using a small group trial. The subjects of the small group trial in this developmental research were third-semester students from the Mathematics Education Program at Universitas Muhammadiyah Sorong, consisting of 15 students. In this study, from a total of 30 students in the class being studied, 15 students were selected as a sample based on the diversity of their learning abilities to ensure a broad representation of the class population. The selection criteria were designed to include students with various levels of mastery of the material, which allows for a deeper analysis of the effectiveness of the developed learning model. This selection process aims to strengthen the validity of the research by ensuring that the sample reflects the diversity present in the larger population. It is important to note that this study did not utilize a comparison group, focusing solely on the 15 selected respondents.

3.3. Types of Data

The data obtained from the product development trial are quantitative in nature. Quantitative data consist of scores given to the students after the field test. This test is used to measure the effectiveness of the developed product. Quantitative data also include observation scores to assess the validity and effectiveness of the learning model produced.

3.4. Data Collection Instruments

Research instruments are tools used to collect data or measure the object of a research variable. To obtain accurate and valid data for conclusions that reflect the actual conditions, it is necessary to use appropriate instruments that consistently provide reliable data from the research (Febrianawati, 2018). The research instruments used in this study include:

1. Need Analysis Instrument

The needs analysis sheet was employed in this study to gather specific information regarding the challenges faced by students during the learning process. This instrument was selected because it allows the researchers to directly identify and address unmet learning needs, which are critical in the development of the CDT model. The information collected through this instrument plays a vital role in tailoring and refining the instructional intervention design to ensure it is more effective and relevant to the actual conditions and learning contexts of the students.

2. Expert Validation Sheet

The expert validation sheet is a crucial instrument used to ensure the accuracy and relevance of the data collected in this study. Subject matter experts and media specialists were involved as validators to assess and verify the components of the developed instructional model, ensuring that both the content and structure align with current educational standards. The use of this validation sheet enabled the researchers to obtain objective and constructive feedback, which is essential for refining and improving the instructional model through iterative development.

3. Response Questionnaire Instrument

The student response questionnaire was utilized in this study to evaluate students' reactions and perceptions toward the implementation of the Component Display Theory (CDT)-based instructional model. This instrument was designed to assess the practicality and feasibility of the developed model, with the aim of ensuring its effective applicability in real classroom settings. The questionnaire employed a Likert scale, allowing students to provide feedback on various aspects of their learning experience.

4. Problem-Solving Ability Test Instrument

The problem-solving ability test instrument was used to measure students' understanding and skills in identifying, analyzing, and solving the given problems. This instrument consisted of open-ended questions that required the application of concepts, logical reasoning, and systematic problem-solving strategies. The use of pretest and posttest formats was chosen to compare students' abilities before and after the implementation of the CDT-based instructional model. This instrument was selected because it provides clear quantitative data on the effectiveness of the instructional intervention being developed.

3.5. Data Analysis Techniques

The data analysis technique is the process of processing data to accurately and objectively understand it, with the aim of finding answers related to the problem statement.

1. Data Analysis on the Improvement of Problem-Solving Skills

To analyze the improvement in students' problem-solving skills, this study employed a quantitative descriptive analysis approach. This method was chosen because it is suitable for illustrating numerical changes in students' scores from the pretest to the posttest. The analysis was conducted using the Normalized Gain (g) formula, which allows researchers to assess the effectiveness of the instructional model by comparing individual score improvements. The formula for calculating Normalized Gain (g) is as follows:

$$(g) = \frac{posttest\ score\ -\ pretest\ score}{maximum\ score\ -\ pretest\ score} \times 100\%$$

The data obtained were processed using Microsoft Excel, which was selected for its efficiency and transparency in handling simple data operations. The results were then categorized based on gain criteria to determine the level of intervention effectiveness, as shown in Table 1. (Karimah, 2018)

Table 1. Criteria for Normalized Gain (g) Acquisition

Normalized Gain (g)	Criteria
$g > 0{,}7$	High
$0{,}3 \leq g \leq 0{,}7$	Medium
$g < 0{,}3$	Low

2. **Analysis of Student Response Data**

The analysis of student response data was conducted to evaluate the level of practicality and acceptance of the developed instructional model. The data were collected through a questionnaire designed using a Likert scale, which is considered effective for quantitatively measuring students' attitudes and perceptions. This method was chosen due to its flexibility in categorizing levels of agreement with statements that represent various aspects of the model's practicality, as presented in Table 2. (Kartini, 2020)

Table 2. Scoring Guidelines

Assessment	Description	Score
SS	Strongly Agree	5
S	Agree	4
KS	Somewhat Agree	3
TS	Disagree	2
STS	Strongly Disagree	1

The percentage of responses from instructors and students can be calculated using the formula:

$$V = \frac{TSe}{TSh} \times 100\%$$

Explanation:

V = Validation

Tse = Total empirical score achieved

TSh = Total expected score

The collected data were analyzed using Microsoft Excel, and the results were calculated in percentage form to be classified into practicality categories based on predetermined standards. The conclusions drawn from the data analysis were aligned with the practicality criteria outlined in Table 3 (Ardy & Hakim, 2021).

https://doi.org/10.22521/edupij.2025.15.175 Published online by Universitepark Press

Table 3. Percentage and Practicality Criteria

Assessment	Percentage	Description
81%-100%	Very Practical	Can be used without revisions
61%-80%	Practical	Can be used with minor revisions
41%-60%	Moderately Practical	Not recommended for use
21%-40%	Not Practical	Cannot be used
0%-20%	Very Impractical	Cannot be used

3. Analysis of Expert Validation Results Data

The analysis of expert validation data was carried out to assess the feasibility and appropriateness of the developed instructional model prior to its implementation in the trial phase. The data were obtained from validation sheets completed by two categories of validators: subject matter experts and instructional model experts. This instrument was selected because it provides an objective evaluation of the model's construct and content aspects, based on each validator's expertise and professional experience (Pratama, 2018). The assessment was conducted using a numerical scale, which was then converted into percentage values; the scoring guidelines for expert validation results are presented in Table 4:

Table 4. Criteria for Learning Model Validity

Score Range	Category
$75 \leq P \leq 100$	Valid
$50 \leq P < 75$	Moderately Valid
$26 \leq P < 50$	Less Valid
$P < 26$	Not Valid

Explanation:

P = Percentage score from experts

∑X = Total average score from experts' responses

N = Maximum score

In addition, qualitative feedback in the form of notes and suggestions from validators was also analyzed as a basis for revising and refining the instructional model.

4. Results

In accordance with the 4-D instructional development model, the following provides a detailed explanation of the development process of the instructional tools, covering the Define, Design, Develop, and Disseminate stages.

4.1. Define stage

The Define stage aims to identify the initial needs in developing the CDT model. The preliminary analysis conducted by the researcher includes needs analysis, curriculum analysis, literature analysis, student analysis, and material analysis to ensure that the developed model aligns with the learning objectives and student requirements.

Curriculum Analysis: Curriculum analysis is conducted to determine the subject matter that will be used in the learning process based on the CDT model. One of the courses listed in the third semester is trigonometric functions. Based on the researcher's observations of the trigonometry course at Universitas Muhammadiyah Sorong, lectures conducted by instructors have not yet implemented the CDT learning model. Additionally, classroom learning tends to be monotonous, leading the researcher to conduct further observations in the trigonometry course. The results of the curriculum analysis include CPL (Course Learning Outcomes) and CPMK (Course Learning Achievement Indicators), which serve as the foundation for implementing the CDT model in the learning process.

4.2. Design Stage

In this stage, the prototype of the learning model to be developed, namely the Component Display Theory (CDT'C), will be designed. The steps undertaken by the researcher include the development of the learning model syntax for CDT'C. This stage involves structuring the syntax of the Component Display Theory and Creation (CDT'C) learning model developed by the researcher. Once all the necessary data has been gathered during the Define stage, the researcher proceeds to organize and formulate the syntax and steps for the CDT'C learning model. In the CDT'C learning model, specific instructional steps are designed for both teachers and students to ensure an effective learning process. The proposed design of the CDT'C model is illustrated in Figure 1.

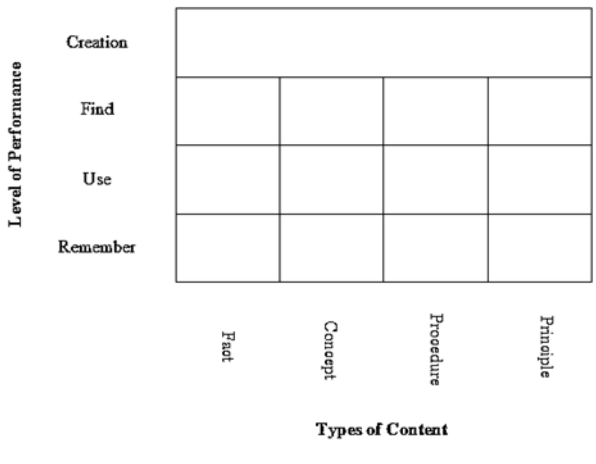

Figure 1. Model CDT'C

4.3. Development Stage

In this stage, the development process is carried out to produce the final version of the learning tools that have been refined based on expert feedback and trial data obtained from the research. The following steps are undertaken during this phase:

Expert Assessment

Before conducting the research, a validation test is performed by experts to evaluate the instruments used in the study. Following the expert validation process, revisions are made based on

https://doi.org/10.22521/edupij.2025.15.175 Published online by Universitepark Press

the feedback and suggestions provided. The validity of the instruments depends on expert assessment, ensuring that the developed model meets the required academic and instructional standards. The results of the learning model validation in this study are illustrated in Figure 2.

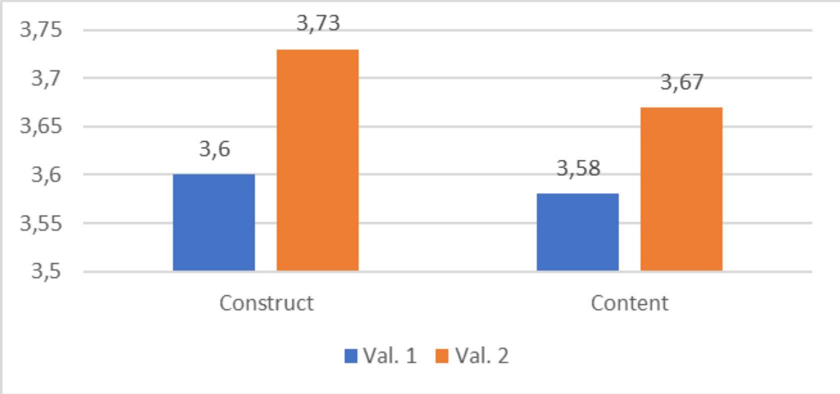

Figure 2. Expert Validation

Based on the construct validation data from experts, the average score obtained was 3.67, with a percentage of 91.67%, indicating that the score falls within the "Valid" category. Meanwhile, based on the content validation data from experts, the average score obtained was 3.63, with a percentage of 90.6%, also classified as "Valid". The researcher has made revisions and improvements to the learning model in accordance with the suggestions provided by the validators.

4.4. Dissemination Stage

After completing the development phase and passing expert validation tests, the CDT model, which has been declared valid, is then disseminated on a limited scale. In this stage, the CDT model is implemented among third-semester students of the Mathematics Education program at Universitas Muhammadiyah Sorong in the Trigonometric Functions course. The dissemination of the CDT model is evaluated by measuring practicality and effectiveness based on collected data, ensuring that the model functions optimally in a real classroom setting.

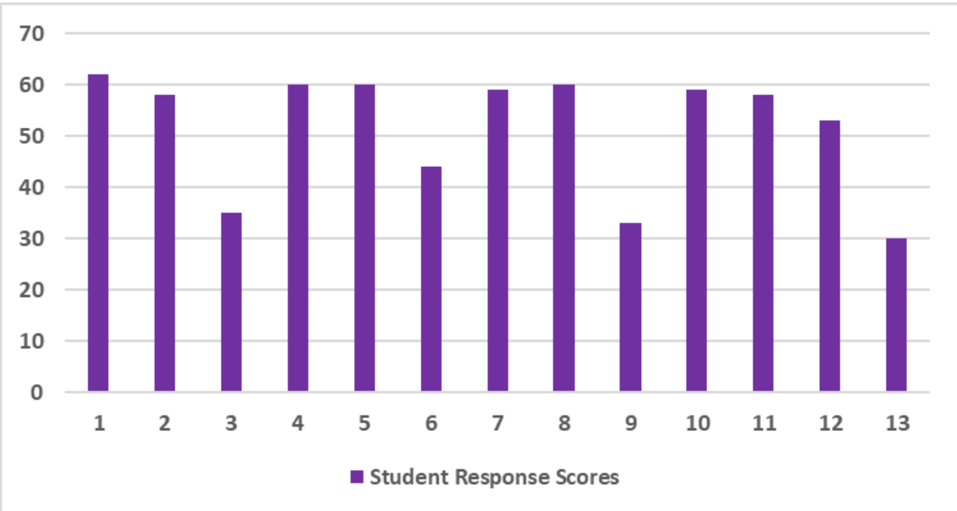

Figure 3. Student Response

The thirteen aspects mentioned above emphasize learning enthusiasm, attractiveness, and work spirit. These aspects influence students' interest, performance, and comprehension in completing the learning process. Additionally, they provide insights into students' responses regarding the direct impact of learning on their ability to understand the given material. Based on student responses to learning using the CDT model, the overall average score obtained was 3.97, with a percentage of 79.41%, which falls under the "Practical" category. Thus, it can be concluded that the CDT learning

https://doi.org/10.22521/edupij.2025.15.175 Published online by Universitepark Press

model helps students understand the material, enhances their problem-solving abilities, and fosters creativity. Furthermore, based on the pretest and posttest results, a descriptive analysis was conducted to determine the gain (improvement) in students' problem-solving skills throughout the learning process.

Table 6. Effectiveness Assessment

Item	Pre-test Score (%)	Category	Posttest Score (%)	Category
Minimum Score	4	Not Effective	25	Less Effective
Maximum Score	8	Not Effective	70	Effective
Mean Score	3,7	Not Effective	47,1	Moderately Effective

Based on the analysis of problem-solving skills presented in Table 6, the results show that the minimum score, maximum score, and mean score in the pre-test fall under the "Not Effective" category. In contrast, for the posttest, the minimum score falls into the "Less Effective" category, the maximum score is categorized as "Effective," and the mean posttest score is classified as "Moderately Effective." Thus, it can be concluded that the CDT model has contributed to improving students' problem-solving abilities.

5. Discussion

This study is developmental research using the 4D model (Define, Design, Develop, and Disseminate). The 4D model consists of four development stages, starting with the Define stage, which aims to identify the initial needs in developing the CDT model. The preliminary analysis conducted by the researcher includes needs analysis, curriculum analysis, literature analysis, student analysis, and material analysis. Needs analysis is carried out to create a product that meets students' needs; curriculum analysis is conducted to determine the type of curriculum used by third-semester students in the Mathematics Education program at Universitas Muhammadiyah Sorong; literature analysis is carried out to obtain theoretical foundations that support problem-solving in the CDT model development. Student analysis is performed to understand student characteristics and determine the steps or learning objectives, while material analysis is conducted to ensure that the teaching materials used align with the competencies students must master.

The second stage, the Design stage, involves designing the CDT model. In this phase, the researcher creates a general framework that includes the development of CDT learning steps, collection of reference materials, structuring of content, and development of Student Worksheets (LKM) aligned with trigonometry materials. The designed framework is reviewed and consulted with academic supervisors, and revisions or improvements are made if necessary. If the design is deemed appropriate, the process proceeds to the next phase, the Develop stage.

The third stage, the Develop stage, involves refining the previously designed framework. Throughout this phase, the researcher consults with academic supervisors at each step to receive feedback and recommendations. The CDT model developed is then re-evaluated by several validators, including construct and content experts. The validation process ensures that the learning model is assessed in terms of its construct and content quality. The validation results from experts serve as a guideline for further revisions, ultimately producing a revised CDT model that meets the required testing standards in terms of construct and content.

https://doi.org/10.22521/edupij.2025.15.175 Published online by Universitepark Press

The final stage, the Disseminate stage, involves testing the validated CDT model with third-semester Mathematics Education students. During this phase, students provide feedback on the CDT model by completing response questionnaires. This process is conducted to gather student responses, suggestions, and necessary corrections for the CDT model under development. In addition to completing response questionnaires, students also take a problem-solving ability test after the learning session using the CDT model to assess the effectiveness of the developed learning model.

Based on expert validation data in the construct and content fields, the average evaluation scores indicate that the CDT model for problem-solving skills falls within the "Valid" category, as assessed using Arikunto’s agreement index criteria from Table 4.3. Consequently, the Component Display Theory model for problem-solving skills is suitable for testing. The CDT model development process is considered valid, aligning with the findings of Kuswandari and Suryanto (2015), who developed interactive multimedia incorporating the CDT model. Their study reported an average content/material validation score of 3.7 (categorized as "Good"), a display aspect score of 3.5 ("Good"), and a learning aspect score of 4.0 ("Good"). This is also consistent with the research by Wantu, Djafri, Lamatenggo, and Umar (2022), which introduced an additional "believing" level within the CDT model, transforming it into CDT'S. Their findings suggest that this model is perceived as more appropriate, considering that self-belief is closely linked to self-awareness, and self-awareness leads to a deeper recognition of one's relationship with God, ultimately fostering a stronger connection to Allah SWT.

6. Conclusion

The conclusions of this study are as follows:

1. The development of the CDT model was carried out using the 4D development model (Define, Design, Develop, Disseminate). In the Define stage, a needs analysis, curriculum analysis, literature analysis, student analysis, and material analysis were conducted. In the Design stage, the development of CDT learning steps, material preparation, and the creation of Student Worksheets (LKM) were carried out. In the Develop stage, the CDT model was enhanced by adding a creation step at the end of the learning process, making learning more creative. The validation results indicate that the developed CDT’C model is categorized as valid and practical.

2. The CDT’C model can improve students' problem-solving skills, falling into the moderate category, which means it is reasonably effective in enhancing students' understanding.

3. The CDT’C model has been shown to increase student engagement in learning, demonstrating a moderate level of effectiveness, making it a practical model for classroom implementation.

7. Suggestion

The recommendations of this study are as follows:

1. The Component Display Theory model can be used as an alternative to enhance students' problem-solving skills in the Trigonometry course.

2. The Component Display Theory model can be further developed to encourage educators to innovate in improving students' problem-solving abilities.

3. The Component Display Theory model can be utilized as an alternative in the learning process to enhance students' problem-solving skills and creativity in other courses.

Declarations

Author Contributions. M.S.K, & S.S: Literature review, conceptualization. M.F & M.A: methodology, data analysis. I.I & W.S: review-editing and writing, original manuscript preparation

Conflicts of Interest. No potential conflict of interest was reported by the author(s)
Ethical Approval. This research adhered to the ethical guidelines set by Universitas Muhammadiyah Sorong. The study was conducted as part of a grant program from the Ministry of Education and Culture of the Republic of Indonesia. It was approved by Universitas Muhammadiyah Sorong with the approval number 064/KTK/II.3.AU/J/2024. All participants were fully informed about the voluntary nature of their participation, the objectives of the study, the protection of data privacy, and the absence of any physical or emotional risks.
Data Availability Statement. All data that support the findings of this study are included in the article.
Acknowledgements. We would like to express our gratitude to the Ministry of Education and Culture for funding this research through the 2024 advanced research grant program.

References

Ardy, I., & Hakim, M. ari. R. (2021). *Kepraktisan Media Pembelajaran Komik Matematika Pada Pendahuluan Pendidikan selalu mengalami perubahan dan perkembangan sesuai dengan adanya perubahan dan perkembangan kehidupan manusia . Oleh karena itu proses pembelajaran yang dilakukan dalam rangka per*. *10*(April), 91–100. https://doi.org/10.33373/pythagoras.v10i1.2934

Cahyanto, B., & Afifulloh, M. (2020). Electronic Module (E-Module) Berbasis Component Display Theory (CDT) Untuk Matakuliah Pembelajaran Terpadu. *JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran): Kajian Dan Riset Dalam Teknologi Pembelajaran*, *7*(1), 49–56. https://doi.org/10.17977/um031v7i12020p049

Ceberio, M., Almudí, J. M., & Franco, Á. (2016). Design and Application of Interactive Simulations in Problem-Solving in University-Level Physics Education. *Journal of Science Education and Technology*, *25*(4), 590–609. https://doi.org/10.1007/s10956-016-9615-7

Damayanti, N., & Kartini, K. (2022). Analisis Kemampuan Pemecahan Masalah Matematis Siswa SMA pada Materi Barisan dan Deret Geometri. *Mosharafa: Jurnal Pendidikan Matematika*, *11*(1), 107–118. https://doi.org/10.31980/mosharafa.v11i1.1162

Dwi Putra, H., Fathia Thahiram, N., Ganiati, M., & Nuryana, D. (2018). Kemampuan Pemecahan Masalah Matematis Siswa SMP pada Materi Bangun Ruang Development of Project-Based Blended Learning Model to Support Student Creativity in Designing Mathematics Learning in Elementary School. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *6*(2), 82–90. http://journal.unipma.ac.id/index.php/jipm

Faoziyah, N. (2022). Kemampuan Pemecahan Masalah Matematis Siswa Melalui Pembelajaran Berbasis Pbl. *JUPE : Jurnal Pendidikan Mandala*, *7*(2). https://doi.org/10.58258/jupe.v7i2.3555

Febrianawati, Y. (2018). Uji Validitas Dan Reliabilitas Instrumen Penelitian Kuantitatif. *Jurnal Tarbiyah: Jurnal Ilmiah Kependidikan*, *7*(1), 17–23. https://doi.org/10.21831/jorpres.v13i1.12884

Gdi, T., & Hidayanto, D. N. (2016). *Pengembangan Pembelajaran IPS SD Berdasarkan Preskripsi "orryponent Display" Theory GDI)*. http://dx.doi.org/10.17977/jip.v6i2.2331

Gorbi Irawan, A., nyoman Padmadewi, N., & Putu Artini, L. (2018). Instructional materials development through 4D model. *SHS Web of Conferences*, *42*, 00086. https://doi.org/10.1051/shsconf/20184200086

Gumisirizah, N., Muwonge, C. M., & Nzabahimana, J. (2024). Effect of problem-based learning on students' problem-solving ability to learn physics. *Physics Education*, *59*(1), 015015. https://doi.org/10.1088/1361-6552/ad0577

Hariyanto, B., MZ, I., SU, W., & Rindawati. (2022). 4D Model Learning Device Development Method of the Physical Geography Field Work Guidance Book. *MATEC Web of Conferences*, *372*, 05008. https://doi.org/10.1051/matecconf/202237205008

Indraswati, D., Marhayani, D. A., Sutisna, D., Widodo, A., & Maulyda, M. A. (2020). Critical Thinking Dan Problem Solving Dalam Pembelajaran Ips Untuk Menjawab Tantangan Abad 21. *Sosial Horizon: Jurnal Pendidikan Sosial*, *7*(1), 12–28. https://doi.org/10.31571/sosial.v7i1.1540

Karimah, S., Utami, R., & Hidayah, N. (2018). Keefektifan Media Pembelajaran Berbasis Edmodo terhadap Kreativitas Mahasiswa. *Jurnal Pendidikan Edutama*, *5*(2), 97. https://doi.org/10.30734/jpe.v5i2.132

Kahar, M. S., Arsyad, R. Bin, Fathurrahman, M., & Mursalin, M. (2023). Component Display Theory (CDT) Learning Model Design in Basic Physics Lectures. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 9629–9635. https://doi.org/10.29303/jppipa.v9i11.5427

Kartini, K. S., Tri, I. N., & Putra, A. (2020). *Respon Siswa Terhadap Pengembangan Media Pembelajaran Interaktif Berbasis Android*. *4*(1), 12–19. https://doi.org/10.23887/jpk.v4i1.24981

Kristianti, D., & Julian, S. (2017). Pengembangan Perangkat Pembelajaran Matematika Model 4D Untuk Kelas Inklusi Sebagai Upaya Meningkatkan Minat Belajar Siswa. *Jurnal MAJU*, *4*(1), 38–50. http://ejournal.stkipbbm.ac.id/index.php/mtk/article/view/71/61

Kuswandari, R. E., & Suryanto, S. (2015). Aplikasi Model Component Display Theory (CDT) Dalam Pengembangan Multimedia Interaktif Matakuliah Jaringan Komputer. *Jurnal Inovasi Teknologi Pendidikan*, *2*(2), 179–189. https://doi.org/10.21831/tp.v2i2.7608

Khan, M. J., & Mustafa, K. (2019b). Modelling adaptive hypermedia instructional system: a framework. *Multimedia Tools and Applications*, *78*(11), 14397–14424. https://doi.org/10.1007/s11042-018-6819-2

Li, X., Rong, J., Li, Z., Zhao, X., & Zhang, Y. (2022). Modeling drivers' acceptance of augmented reality head-up display in connected environment. *Displays*, *75*, 102307. https://doi.org/10.1016/j.displa.2022.102307

Merrill, M.D. (1983). Component Display Theory. In C. Reigeluth (ed.), *Instructional Design Theories and Models.* Hillsdale, NJ: Erlbaum Associates.

Merrill, M. (1987). The new Component Design Theory: instructional design for courseware authoring. *Instructional Science*, *16*(1), 19–34. https://doi.org/10.1007/BF00120003

Merrill, M. D. (2007). A Task-Centered Instructional Strategy. *Journal of Research on Technology in Education*, *40*(1), 5–22. https://doi.org/10.1080/15391523.2007.10782493

Merrill, M. D. (2018). A Lesson Based on the Component Display Theory. In *Instructional Theories in Action* (pp. 201–244). Routledge. https://doi.org/10.4324/9780203056783-7

Nicholus, G., Muwonge, C. M., & Joseph, N. (2023). The Role of Problem-Based Learning Approach in Teaching and Learning Physics: A Systematic Literature Review. *F1000Research*, *12*, 951. https://doi.org/10.12688/f1000research.136339.2

Park, S., Kim, L., Kwon, J., Choi, S. J., & Whang, M. (2022). Evaluation of visual-induced motion sickness from head-mounted display using heartbeat evoked potential: a cognitive load-focused approach. *Virtual Reality*, *26*(3), 979–1000. https://doi.org/10.1007/s10055-021-00600-8

Purnawati, P., Umar, M. K., & Abdjul, T. (2023). Development of Physics Teaching Module for Phase-E with the CDT (Component Display Theory) Approach. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 12200–12212. https://doi.org/10.29303/jppipa.v9i12.5722

Renkl, A., & Scheiter, K. (2017). Studying Visual Displays: How to Instructionally Support Learning.

Educational Psychology Review, *29*(3), 599–621. https://doi.org/10.1007/s10648-015-9340-4

Tenzin, S., Tendar, P., & Zangmo, N. (2022). *Enhancing Students' Understanding of Abstract Concepts in Physics by Integrating ICT in Teaching-Learning Process*. Asian Journal of Education and Social Studies, 26(2), 68-80. https://doi.org/10.9734/ajess/2022/v26i230624

Troussas, C., Krouska, A., & Sgouropoulou, C. (2021). Improving Learner-Computer Interaction through Intelligent Learning Material Delivery Using Instructional Design Modeling. *Entropy*, *23*(6), 668. https://doi.org/10.3390/e23060668

Wantu, H. M., Djafri, N., Lamatenggo, N., & Umar, M. K. (2023). Classroom Learning Management Using Component Display Theory in Islamic Education Courses. *International Journal of Professional Business Review*, *8*(7), e02512. https://doi.org/10.26668/businessreview/2023.v8i7.2512

Wells, M., Hestenes, D., & Swackhamer, G. (1995). A modeling method for high school physics instruction. *American Journal of Physics*, *63*(7), 606–619. https://doi.org/10.1119/1.17849

About the Contributor(s)

Muhammad Syahrul Kahar is an associate professor of education at the Faculty of Teacher Training and Education, Universitas Muhammadiyah Sorong, Sorong, Indonesia. His research focuses on Learning Models and Physics Education.
Email: syahrulkahar@um-sorong.ac.id / muhammadsyahrulkahar@gmail.com
ORCID: https://orcid.org/0000-0003-4899-4836

Irmawati is a student at the Faculty of Teacher Training and Education, Mathematics Education Study Program, University of Muhammadiyah Sorong Southwest Papua.
Email: irmawatiabubakar0@gmail.com
ORCID: https://orcid.org/0009-0009-4253-9585

Muhammad Fathurrahman is a Lecturer at the Faculty of Teacher Training and Education, Mathematics Education Study Program, Universitas Muhammadiyah Sorong. He completed his bachelor's degree in mathematics education at Universitas Muhammadiyah Sorong in 2013, his master's degree in mathematics education at Makassar State University in 2016, and his Doctorate in Education at Gorontalo State University in 2023. Fathurrahman was appointed as a lecturer in 2017 and has research interests focused on the development of learning technologies in mathematics, technology-integrated learning models, and the integration of artificial intelligence in education. He is very passionate about improving the quality of learning and the development of students both in school and higher education environments.
Email at r.fathur.ums@gmail.com
ORCID: https://orcid.org/0000-0003-4078-2943

Suparman, Ph.D is a professor in applied mathematics at the Faculty of Teacher Training and Education, Universitas Ahmad Dahlan, Yogyakarta, Indonesia. His research focuses on mathematics education and applied mathematics.
Email: suparman@pmat.uad.ac.id
ORCID: https://orcid.org/0000-0001-5526-6285

Wanida Simpol is an educator working in Loei Province, Thailand. She is also involved as a digital creator and has an educational background from Chulalongkorn University and Loei Rajabhat University. Currently, she works at the Loei Provincial Education Office.
Email: sowanida@gmail.com

ORCID: https://orcid.org/0009-0003-1873-4950

Muhammad Ali is an associate professor of education at the Faculty of Social Science and Political Science, Universitas Muhammadiyah Sorong, Sorong, Indonesia. His Research focuses on Social and Sociology.
Email: muhammadali@um-sorong.ac.id
ORCID: https://orcid.org/0000-0003-4899-4836